The Processing of CCD Images of the Lagoon Nebula, M8

Mr. Taran Tulsee
Queensborough Community College

ABSTRACT:

MU-SPIN NRTS South Carolina State University and City College of New York have collaborated to fund student astrophysical research during the summer of 1998. The program was funded by a grant from the National Aeronautics and Space Administration (NASA), through MU-SPIN (NCC5-116), NASA-URC (NCC5-228) and other NASA sources. The results of one such student are presented.

Previously obtained CCD images taken in Baja, Mexico at the San Pedro Martir Observatory have been reduced and calibrated for future scientific examination. CCDs and their applications to astronomy are briefly discussed. The well known IRAF software package was used to reduce the images from raw to calibrated form. This included the removal of the following noise sources: bias frames, dark frames, bad pixel columns, cosmic rays, and flat field variations.

The data reduction was applied to images obtained at wavelengths of 5755 and 6584 angstroms emitted by the singly ionized nitrogen atom. The temperature map which results from this study will be compared to the temperature map obtained using emission line images from doubly ionized oxygen as discussed elsewhere in this conference (see Ely Duenas' poster).

SUMMARY

INTRODUCTION**:**

This work is the result of an eight-week collaboration between South Carolina State University (SCSU), City College of New York (CCNY), and Queensborough Community College (QCC). The principal investigator, Dr. Donald K. Walter is at SCSU, while the coordinator in New York is Dr. Shermane Austin of CCNY. At QCC the coordinator is Dr. Donald Cotten, Chairman of the Physics Department.

The object studied is one of the Messier objects known as M8, the eighth object in Messier's catalog. M8 is also called the Lagoon Nebula and is located in the constellation Sagittarius. Modern astronomers define it as an 'H II' region, meaning that it consists largely of protons and electrons freed from atomic hydrogen. In an H II region, which may be up to tens of light years across, atomic hydrogen is ionized by electromagnetic radiation of wavelength 912 Angstroms or shorter emanating from a star or stars embedded in the region. This creates a plasma of free protons and electrons. What we observe is radiation which is emitted when recombination takes place and energy is released in all the hydrogen series; Lyman, Balmer, and so forth. Additionally, radiation is emitted from collisionally excited ions of the various chemical elements such as oxygen and nitrogen. As a result, M8 is also called an emission nebula.

CCD's:

A CCD, or charge-coupled device, is an array of sensors which detect electromagnetic radiation. When electromagnetic radiation (e.g. visible light or ultraviolet light) strikes a CCD, individual photons impinge on the pixels and free electrons which remain inside the pixel until the end of the exposure, at

which time the chip is "read out" and the data is stored in a computer. There is a direct relation between the charge and the intensity of the radiation to which the pixel was exposed. The information for a particular exposure can be displayed as a grid of numbers or as an image after being processed by a computer program.

DATA REDUCTION**:**

To process the images of M8 obtained previously by other astronomers, the author used a software package known as the Image Reduction and Analysis Facility (IRAF). This is a general purpose image processing package used in the analysis of astronomical data. IRAF was created by the National Optical Astronomy Observatories, under a cooperative agreement with the National Science Foundation. IRAF is a very versatile software facility, being able to execute a myriad of processes on an image, too numerous to list here. As an example, with one tool called 'cosmicrays' one can remove cosmic ray hits from an image.

When an image is recorded by a CCD, there are various unwanted effects (noise) which must be dealt with in processing the image. Sources of noise are cosmic rays, dark current, bias or read noise and flat fielding. During the course of this summer research project, all of these sources of noise were examined and removed from the images, leaving behind scientifically useful data.

RESULTS:

The reduction described above was applied to a set of CCD images of M8 previously obtained at the San Pedro Matir Observatory. The wavelengths of interest to this study were at 5755 and 6584 angstroms, both emitted by singly ionized nitrogen atoms. The ratio of these two images was used to derive a preliminary temperature map of the nebula. Final analysis of the map awaits further study, at which time it will be published and made available for use by other astronomers who study the interstellar medium.